Chapter 4

The Nautical Road

Introduction

In this chapter, you will be introduced to the components of the maritime highway. Just as you would travel along a roadway in your car by referring to a map and the road signs, the high seas, coastal approaches, and harbors all have unique signposts to help ships find their way.

The Nautical Road is comprised of two separate areas; Aids to Navigation (ATONs) and the Navigation Rules. The ATONs are like the signposts on the highway and the Navigation Rules compare to the traffic laws that we follow.

Objectives

Completion of this material will enable the student to:

- Identify buoyage systems.
- Recognize buoy types and state their purpose.
- Compute the visibility of navigational lights.
- Recognize day and range markers and state their purpose.
- State the purpose of the rules of the road.
- Describe all steering and sailing rules.
- List at least four elements that make up an ATON's characteristics.
- Identify the following characteristics of ATON:
  a. Color
  b. Light rhythm and cycle
  c. Number
- State the two factors that determine the visibility of a lighted ATON.
- Identify the following terms associated with light visibility computations:
  a. Horizon distance
  b. Meteorological visibility
  c. Luminous range
  d. Nominal range
  e. Geographic range
  f. Computed range
  g. Computed visibility

Objectives, Continued

Objectives

- List the three elements used to identify a light at night.
- State the differences between primary and secondary lights.
- List two purposes of ranges.
- Identify the differences between directional lights, daybeacons, and minor lights.
- Describe how light sector bearings are plotted on charts.
- State the reason why sound signals are used on ATONs.
- State the purpose of a RACON.
- Identify the function of a buoyage system.
- List the characteristics of lateral and cardinal buoyage systems.
- Identify the differences between IALA region A and IALA region B.
- State which IALA region applies to the United States.
- Identify and explain variations in the following U.S. Systems of ATONs:
  a. Intracoastal waterway (ICW)
  b. Western rivers
  c. Uniform State Waterway Marking System (USWMS)
- Identify and distinguish between international and inland rules of the road.

Navigational Lights

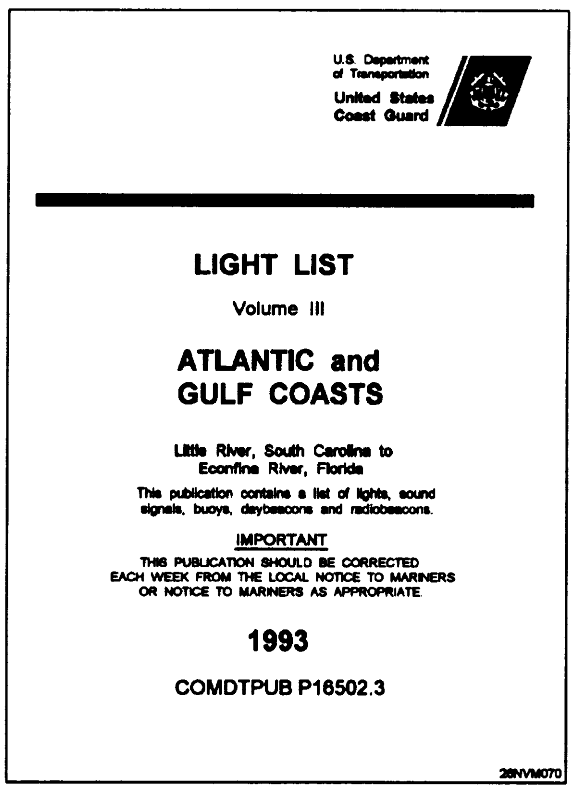
Information

A ship cannot suspend operations merely because darkness falls and daytime aids cannot be distinguished. For that reason, aids to navigation are lighted whenever it is necessary and practical. For purposes of identification, lights have **individual characteristics** regarding ***color, brilliancy, and system of operation.***

A light's characteristics are usually printed on the chart near its symbol. Detailed information on any particular aid to navigation may be found in the appropriate volume of the *Light List.*

As you learned in the previous chapter, the Defense Mapping Agency Hydrographic/ Topographic Center (DMAHTC) publishes *List of Lights* in seven volumes which cover aids to navigation outside the continental United States.

Aids located in the United States and its possessions are described in *Light List* volumes published by the U.S. Coast Guard.


U.S. Department of Transportation
United States Coast Guard

LIGHT LIST

Volume III

ATLANTIC and GULF COASTS

Little River, South Carolina to Econfina River, Florida

This publication contains a list of lights, sound signals, buoys, daybeacons and radiobeacons.

IMPORTANT

THIS PUBLICATION SHOULD BE CORRECTED EACH WEEK FROM THE LOCAL NOTICE TO MARINERS OR NOTICE TO MARINERS AS APPROPRIATE.

1993

COMDTPUB P16502.3

26NVM070

Figure 4-1. Light List.

Light List

Introduction

Since the *Light List* is such an important publication for the Quartermaster, and because you will no doubt use it frequently, we will review it in greater detail here.

Light List for the United States and its possessions, including the Intracoastal Waterway, the western rivers, and the Great Lakes for both the United States and Canadian waters, are published annually by the U.S. Coast Guard in six volumes.

Composition

Each volume provides information on ATONs within a specific area of the country; for example, Volume I, Atlantic Coast, describes aids to navigation from St. Croix River, Maine, to Toms River, New Jersey. Volume VI, Pacific Coast and Pacific Islands describes aids to navigation on the Pacific Coast and outlying islands and so on.

The aids are listed such that seacoast aids appear first, followed by entrance and harbor aids from seaward to the head of navigation. Light List Numbers (LLNR) are assigned to all ATONs to facilitate reference in the *Light List* and to resolve ambiguity when referencing ATONs. Table 4-1 explains the page layout of the *Light List.*

Table 4-1. Sample of *Light List*

(1) No.	(2) Name and location	(3) Position	(4) Characteristic	(5) Height	(6) Range	(7) Structure	(8) Remarks
			GEORGIA- Seventh District				
	Whitehall Channel						
4445	SAVANNAH BULK TERMINAL SOUTH LIGHT	32 08.0 81 08.5	**F G**	24		On pier	Private Aid
4450	SAVANNAH BULK TERMINAL NORTH LIGHT		**F G**	24		On pier	Private Aid
Column (1)	Column (2)	Column (3)	Column (4)	Col (5)	Col (6)	Column (7)	Column (8)
Light List Number	Name of the aid to navigation	Geographic position in latitude and longitude	Light characteristic for a lighted aid to navigation. Morse code for a radiobeacon	Height of light above mean high water	Nominal Range	See Below	See Below

Column (7) Structural characteristic of the aid to navigation, including dayboard (if any), description of fixed structure, color and type of buoy, and height of the structure above ground.

Column (8) General remarks, including fog signal characteristic, RACON characteristics, lights sector's arc of visibility, radar reflector if installed, emergency lights, seasonal remarks, and private aid identification.

How to Use the Light List

Example

Using the *Light List* is simple. As an example, suppose you need to know the position and characteristic of Key West Harbor Range. To find this information in the *Light List* follow these three steps while referring to table 4-2.

Step	Action
1.	Look up the LLNR for Key West Harbor Range in the index.
2.	Next, find the page listing LLNR 12990 in the main pages. Each aid to navigation is listed numerically by LLNR.
3.	Extract the information you need for the aid. In this case, the position of the light is 24°34.7'N, 081°48.0'W; characteristic is quick flashing white.

Key West Harbor Main Channel	**12890**
KEY WEST HARBOR RANGE .... LLNR ☞	12990

Table 4-2. Excerpt from *Light List*, Volume III, 1993

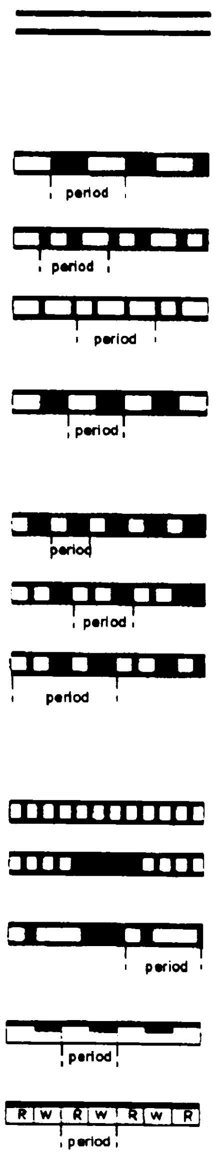
(1) No.	(2) Name and location	(3) Position	(4) Characteristic	(5) Height	(6) Range	(7) Structure	(8) Remarks
	KEY WEST HARBOR AND APPROACHES						
	Key West Harbor Main Channel						
12985	- *Lighted Buoy 15*		**Fl G 4'**		**4**	**Green**	
12990	KEY WEST HARBOR RANGE FRONT LIGHT	24 34.7 81 48.0	**Q W**	16		**KRW on Dolphin**	**Visible all around**

Characteristics of Lighted Aids to Navigation

Introduction

Lights displayed from ATONs have distinct characteristics (rhythms) which help you identify them. They all exhibit a distinctive flashing rhythm. Use figure 4-2 to find the characteristic for any light.

CHARACTERISTICS OF LIGHTS



Type Description	Abbreviation
1. FIXED. A light is showing continuously and steadily.	F
2. OCCULTING. A light which the total duration of light in a period is longer than the total duration of darkness and the intervals of darkness (eclipses) are usually of equal duration.	
2.1 Single - occulting. An occulting light in which an eclipse is regularly repeated.	Oc
2.2 Group - occulting An occulting light in which a group of eclipses, specified in numbers, is regularly repeated.	Oc(2)
2.3 Composite group - occulting. A light, similar to a group - occulting light, except that successive groups in a period have different numbers of eclipses.	Oc(2+1)
3. ISOPHASE. A light in which all durations of light and darkness are equal.	Iso
4. FLASHING. A light in which the total duration of light in a period is shorter than the total duration of darkness and the appearances of light (flashes) are usually of equal durati	
4.1 Single - flashing. A flashing light in which a flash is regularly repeated (frequency not exceeding 30 flashes per minute).	Fl
4.2 Group - flashing. A flashing light in which a group of flashes, specified in number, is regularly repeated.	Fl(2)
4.3 Composite group - flashing. A light similar to a group (flashing light except that successive groups in the period have different numbers of flashes.	Fl(2+1)
5. QUICK. A light in which flashes are produced at a rate of 60 flashes per minute.	Q
5.1 Continuous quick. A quick light in which a flash is regularly repeated.	
5.2 Interrupted quick. A quick light in which the sequence of flashes is interrupted by regularly repeated eclipses of constant and long duration.	IQ
6. MORSE CODE. A light in which appearances of light of two clearly different durations (dots and dashes) are grouped to represent a character or characters in the Morse co	Mo(A)
7. FIXED AND FLASHING. A light in which a fixed light is combined with a flashing light of higher luminous intensity.	FFl
8. ALTERNATING. A light showing different colors alternately.	Al RW

26NVM071

Figure 4-2. Light characteristics.

Defined

Some aids, such as safe-water marks always use the same rhythm (Morse "A"), while others may display one of several different rhythms. Figure 4-2 on the previous page gives a description and definition of light characteristics (rhythms) as well as their chart symbol abbreviations. Abbreviations are used on charts because of space restrictions.

When working with composite light abbreviations, you must carefully distinguish between the meanings of the numbers in parentheses following a composite-flashing light. In the case of the composite-flashing light, the numbers refer to the pattern of the flashes of light. On the contrary, when the light is a composite-occulting light, the numbers within the parentheses denote the pattern of the eclipses in the light.

Light Cycle

The "Light Cycle," or period of a light, is the time it takes a light to complete one full cycle of ON and OFF changes. By varying the length of the cycles, a clear distinction can be made between numerous aids in the same area.

Numbering and Lettering

All solid red and solid green ATONs are numbered. Red aids have even numbers; green aids have odd numbers. The numbers for each increase from seaward, proceeding in the conventional direction of buoyage. Numbers are kept in approximate sequence on both sides of the channel by omitting numbers where necessary.

Letters may be used to augment numbers when lateral aids are added to channels with previously completed numbering sequences. If letters are used, they will increase in alphabetical order from seaward and will be added to numbers as suffixes.

No other aids are numbered. Preferred-channel, safe-water, isolated danger, special marks, and information or regulatory aids may be lettered, but not numbered.

Visibility of Lights

Information

The visibility of a lighted ATON depends upon two factors: **the light's intensity** and the **light's height above water.** There will be times when you will want to know the specific distance at which you will be able to see a light, such as approaching land from sea. This information can be helpful in determining the ship's position.

<u>**Rule:**</u> When a ship is under way all navigational lights that will be sighted during periods of darkness must be identified in the Captain's Night Orders. It is desirable to also define the time at which the light should be sighted.

Process

Refer to the following table to view the process of determining the visibility of a light.

Step	Action	Result
1.	Locate the light on the chart and note the name of the light.	Information gained for obtaining LLNR from the Light List.
2.	Extract the characteristics from the Light List.	Height of eye computation can now be done.
3.	Compute the distance at which the light should be sighted from the height of eye table.	Information concerning when a light should be sighted is obtained.

Table 4-3. Height of Eye

Height		Distance Nautical	Height		Distance Nautical	Height		Distance Nautical
Feet	Meters	Miles	Feet	Meters	Miles	Feet	Meters	Miles
5	1.5	2.6	70	21.3	9.8	250	76.2	18.5
10	3.1	3.7	75	22.9	10.1	300	91.4	20.3
15	4.6	4.5	80	24.4	10.5	450	106.7	21.9
20	6.1	5.2	85	25.9	10.8	400	121.9	23.4
25	7.6	5.9	90	27.4	11.1	450	137.2	24.8
30	9.1	6.4	95	29.0	11.4	500	152.4	26.2
35	10.7	6.9	100	30.5	11.7	550	167.6	27.4
40	12.2	7.4	110	33.5	12.3	600	182.9	28.7
45	13.7	7.8	120	36.6	12.8	650	198.1	29.8
50	15.2	8.3	130	39.6	13.3	700	213.4	31.0
55	16.8	8.7	140	42.7	13.8	800	243.8	33.1
60	18.3	9.1	150	45.7	14.3	900	274.3	35.1
65	19.8	9.4	200	61.0	16.5	1000	304.8	37.0

Understanding the Relationships Among Terms

There are several terms associated with any light's visibility. Figure 4-3 will help you to visualize the relationships existing among these terms as they apply in a situation in which an observer with a height of 50 feet is located exactly at the computed range to a light having a geographic range of 11.7 miles and a nominal range of 15 miles. Review figure 4-3 and the associated terms list on the next page.

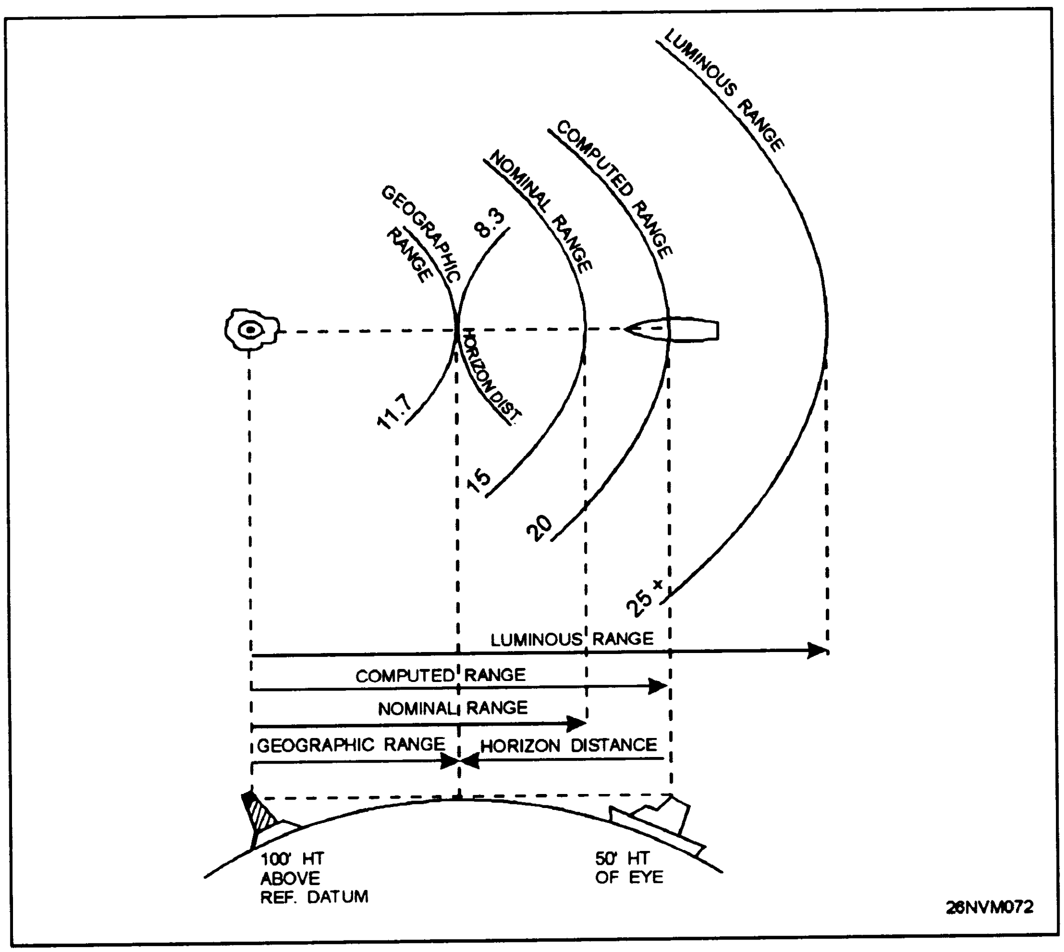


Figure 4-3. Relationship of light visibility terms.

Terms

The following is a list of terms associated with light visibility computations:

Horizon distance - This is the distance expressed in nautical miles from the position above the surface of Earth along a line of sight to the horizon; the line along which Earth and sky appear to meet. The higher the position, the farther the horizon distance will be. Figure 4-3 shows the relationship of height of eye to horizon distance.

Meteorological visibility - Meteorological visibility results primarily from the amount of particulate matter and water vapor present in the atmosphere at the location of an observer. It denotes the range at which the unaided human eye can see an unlighted object by day in a given set of meteorological conditions.

Luminous range - Luminous range is the maximum distance at which a light may be seen under the existing meteorological visibility conditions. Luminous range does not take into account the height of the light, the observer's height of eye, or the curvature of Earth. It depends only on the intensity of the light itself.

Nominal range - Nominal range is the maximum distance a light can be seen in **clear** weather (meteorological visibility of 10 nautical miles). Nominal range is similar to luminous range in that it does not take into account elevation, height of eye, or curvature of Earth, but it depends on the intensity of the light. Nominal range is listed in column 6 of the *Light List* for all lighted aids to navigation except range lights, directional lights, and private aids to navigation.

Geographic range - Geographic range is the maximum distance at which a light may be seen in perfect visibility by an observer whose eye is at sea level.

Computed range - Computed range is the geographic range plus the observer's distance to the horizon based on the observer's height of eye.

Computed visibility - Computed visibility is the visibility determined for a light using the light's height, nominal range, and height of eye of the observer.

How to Compute the Visibility of a Light

Information

Frequently, the navigator will want to know at what time and position on the ship's track a given light might be sighted. This information is especially important when the ship is making a landfall. Failure to sight certain lights when expected could mean that a navigational error has been made. The distance calculated is termed the *computed visibility* of the light.

Rule: When you compute the visibility of a light, the computed visibility will **NEVER** exceed the light's luminous range.

Examples

The following examples illustrate the recommended procedure for determining the visibility of a light. Bear in mind that computed visibility cannot be greater than the luminous range.

Example 1: Determine the visibility of light Alpha for an observer with a height of eye of 50 feet.

Solution: From the *Light List*, the nominal range is determined to be 20 miles; the height of light Alpha is 90 feet above the water. Determine horizon distance from table 4-1.

Height of eye for 50 feet	8.3 miles
Height of light (80 feet)	11.1 miles
Computed visibility	19.4 miles
Nominal range	20.0 miles
Answer:	19.4 miles

Example 2: Determine the visibility of light Bravo for an observer with a height of eye of 35 feet.

Solution: From the *Light List*, determine the nominal range (10 miles) and the height of the light above water (80 feet). Determine horizon distance from table 4-1.

Height of eye for 35 feet	6.9 miles
Height of light (80 feet)	10.5 miles
Computed visibility	17.4 miles
Nominal range	10.0 miles
Answer:	10.0 miles

Luminous Range Diagram

Luminous Range Diagram

The luminous range diagram (fig. 4-4) enables the mariner to determine the approximate range at which a light may be sighted at night in the existing meteorological visibility at the time of observation.

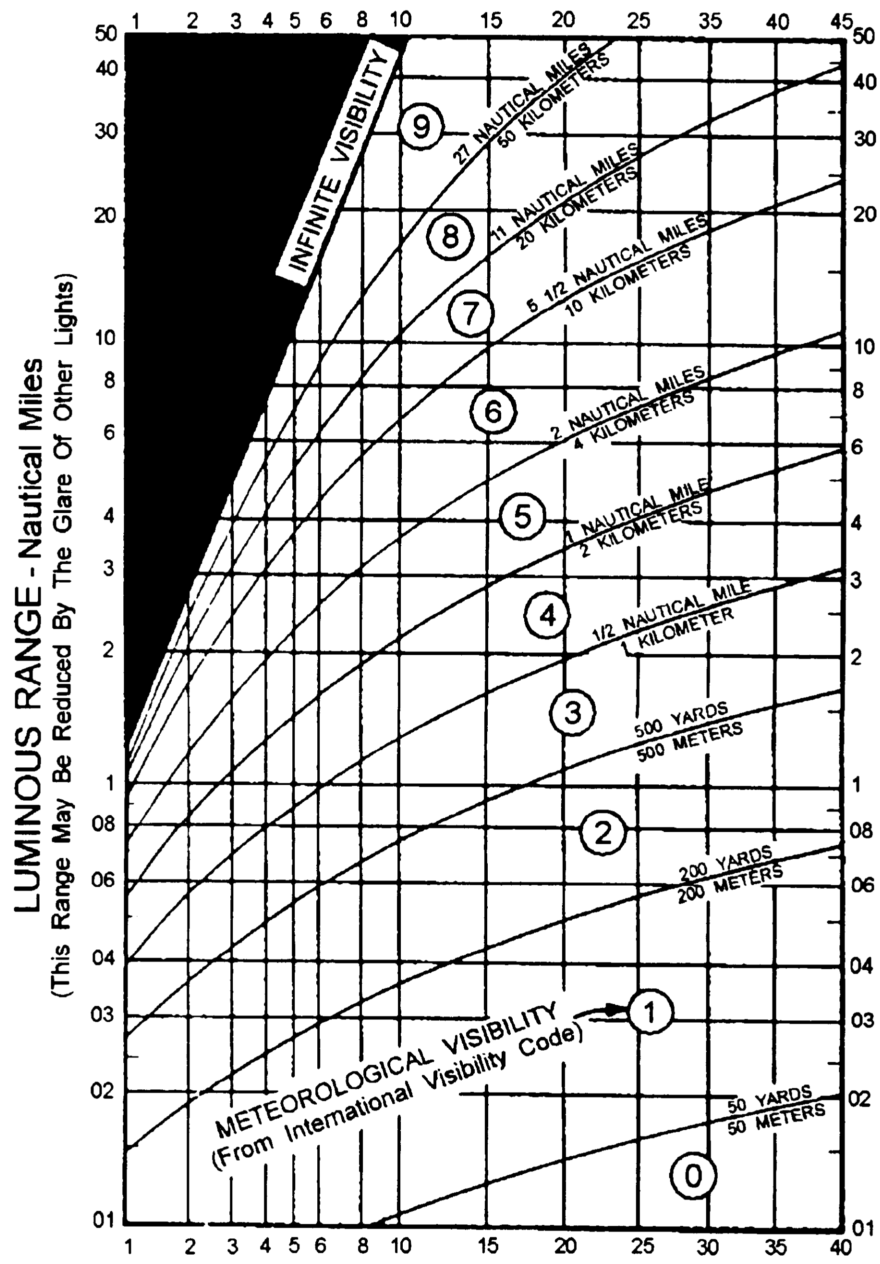


Figure 4-4. Luminous range diagram.

How to Use the Luminous Range Diagram

How to Use the Luminous Range Diagram

The diagram is entered from the top or bottom border, using nominal range obtained from *the Light List.* The figures along the curves represent the estimated meteorological visibility at the time of observation, and those along the left-hand border represent the luminous range under those conditions.

<u>Example:</u> A light has a nominal range of 20 miles. If the meteorological visibility is 20 miles, the light would be sighted at about 33 miles. If the meteorological visibility is only 5 miles, the luminous range of the light is about 12 miles.

When using this diagram, you must remembered that:

- the range obtained is approximate.
- atmospheric conditions may not be consistent between the observer and the light.
- the glare of background lighting will reduce the range at which light is sighted.

Types of Lights and Light Structures

Information

Primary and secondary lights are so designated because of their importance as ATONs. Primary seacoast aids are distinctive lights in the U.S. system of ATONs. They are "fixed" as opposed to "floating" and are maintained on the mainland, or on offshore islands and shoals to warn mariners of the nearness of land or dangers. They are usually the first ATONs that the navigator sees when making a landfall. The navigator can use these lights to keep farther offshore at night. When lights are located offshore, they mark a specific hazard or serve as a marker for ships approaching a major harbor.

Many lights are classified as primary lights because of the importance of their location, their intensity, and the prominence of their structures. Other aids are classed as secondary or minor lights because of their lesser qualities in one or more of these characteristics. The dividing line is not clear cut, and the difference is of no significance when applied to piloting situations.

Lighthouses

These familiar structures are typical primary lights found along the coastlines around much of the world. Lighthouses are placed on prominent headlands and other points such as harbor entrances and isolated dangers to warn mariners of danger or to guide them. The principal purpose of the structure is to support a light source and lens at a considerable height above the water. The same structure may also house a fog signal, a radiobeacon, RACON, and other equipment.

Lighthouses vary greatly in shape and construction (fig. 4-5), which is determined in part by their location (whether in the water or on shore), the importance of their light, the kind of soil on which they are constructed, and the prevalence of violent storms. Since lighthouses are nonlateral aids, their paint color schemes are quite different than traditional lateral marks. Lighthouse structures are painted in various patterns such as stripes and solids, which help mariners to easily distinguish them from other such structures in the same vicinity.

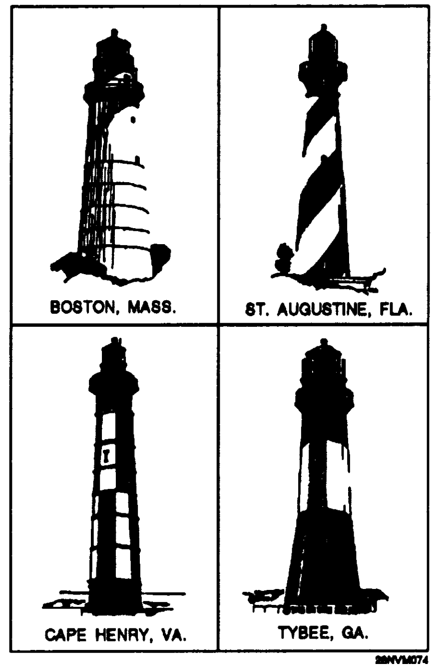


Figure 4-5. Typical lighthouses.

Light Towers

For many years, lightships were used to mark offshore dangers or mark the entrances to important harbors. Today, however, lightships are no longer used in the United States. Instead, they have all been replaced by light towers or large navigational buoys (LNBs) which, especially in the case of the LNB, are much more economical to maintain.

A typical tower deckhouse is 60 feet above the water, 80 feet square, and supported by steel legs in pilings driven nearly 300 feet into the ocean bottom. Though once manned, these light towers are now automated. The light tower has a helicopter landing deck and houses equipment such as a radiobeacon, RACON, fog signal, and communications equipment. On one comer of the deckhouse is a radio tower supporting the radiobeacon antenna and a powerful light. At an elevation of 125 feet above the water, the light is visible for over 20 miles. Although construction details of other towers vary slightly, they are of the same general type.

Ranges

One purpose of a range is to assist mariners in keeping their vessels on the centerline of a channel. The range may be lighted or unlighted and consists of two lights and daymarks located some distance apart with the front display lower than the rear. When the range markers appear one over the other as shown in figure 4-6, the vessel will remain within the limits of the channel. Another purpose of a range is to determine a ship's gyro error.

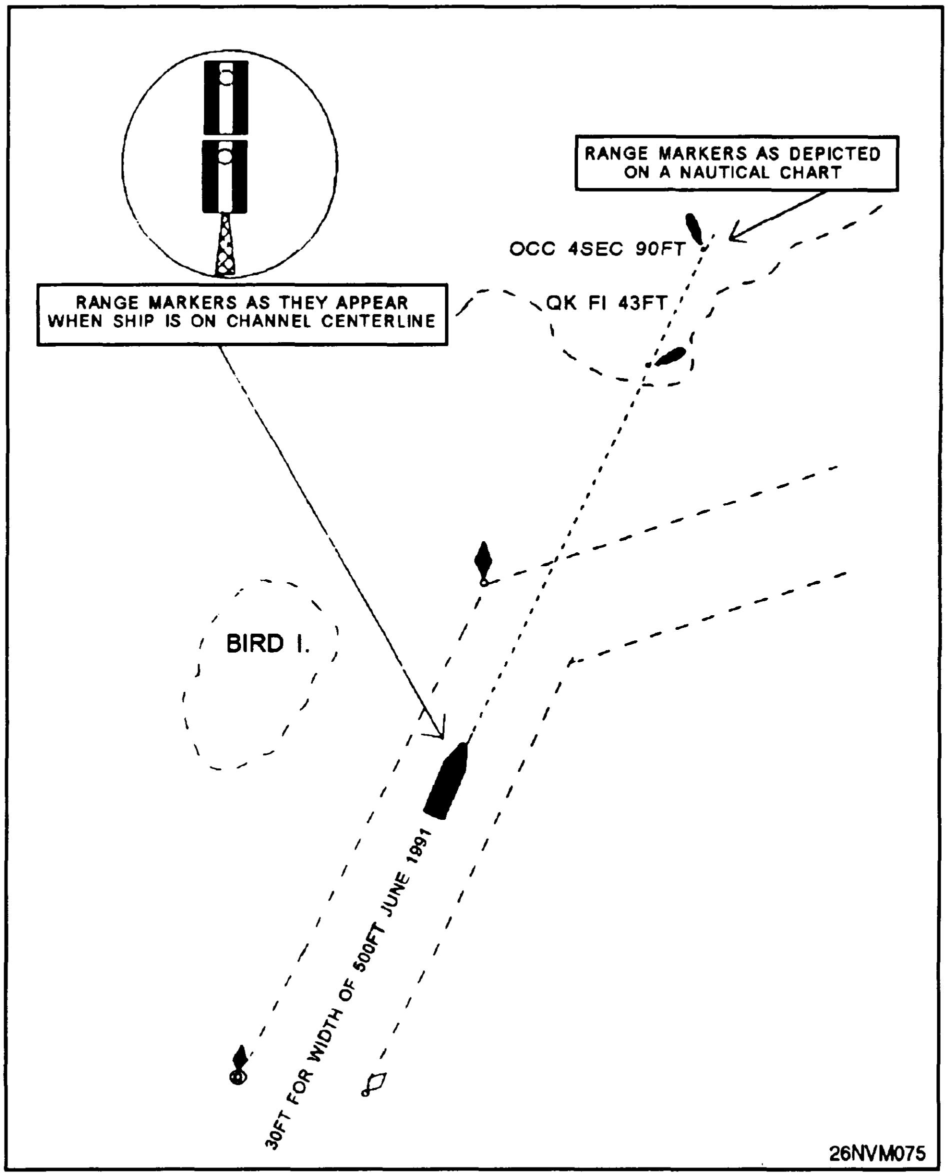


Figure 4-6. Using range markers.

Ranges continued

For a given range, the true bearing of the range axis will be listed in column 2 of the *Light List* immediately below the name of the rear range. As you approach this range and line up the lights and daymarks as shown in figure 4-6, you are on channel centerline. In figure 4-6, if the channel axis is listed as 020° and your ship has the markers in line, your gyro compass should read 020°. If it does not, the difference in degrees will equal your gyro error.

While the range markers discussed above are precisely positioned to mark a channel, you should also be aware that natural ranges are also used on occasion. For example, a tank and a radio antenna, when observed in line, may form a natural range marking safe water.

Directional Lights

In certain situations where range lights are desirable but not practicable to build, a less effective, but generally accepted substitute known as a directional light is used. A directional light illuminates a sector or displays a very narrow angle light beam for a ship to follow. In some cases, three colors of light are used. A high intensity white light will be bordered on each side with a green and red light. The green sector will mark the side of the channel with green buoys, and the red sector marks the side with red buoys. Remaining in the white sector keeps you in the channel.

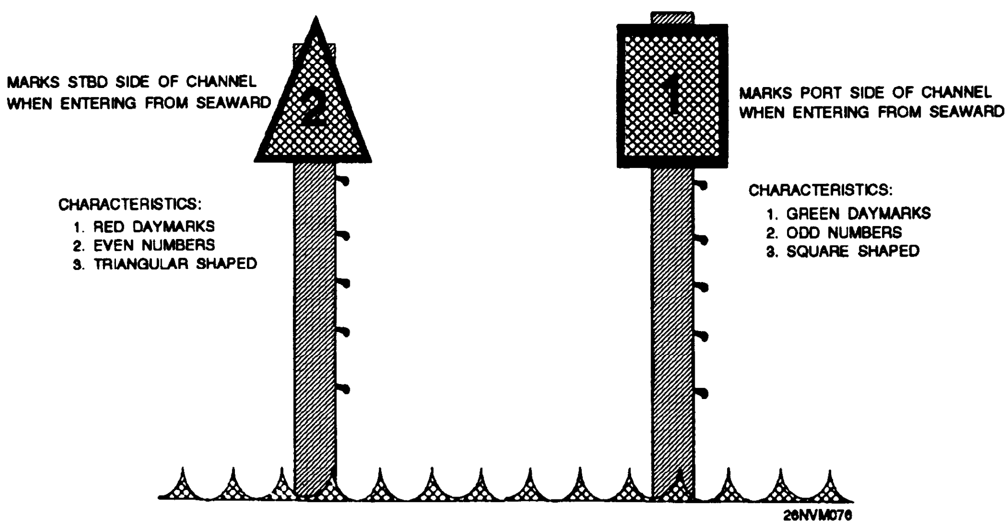


Figure 4-7. Daymarks.

Daybeacons

There are many ATONs that are not lighted, especially in the inland waters of the United States. Structures of this are called daybeacons (fig. 4-7). They are not buoys, but are permanently mounted in position. Daybeacons vary greatly in design and construction, depending on their location and the distance from which they must be seen. A daybeacon may consist of a single pile with a daymark on the top, a multi-pile structure, a tower, or a structure of masonry or steel. Daybeacons are fitted with reflecting tape to facilitate their identification by searchlight at night. Daymarks marking the sides of channels are colored and numbered in the same manner as buoys, with red even-numbered marks indicating a starboard-side channel boundary and green odd-numbered marks on the portside channel boundary. The shapes for channel, preferred-channel, nonlateral, and safe-water daymarks, together with their chart symbols, are shown in chart No. 1 and on plate 1.

Minor Lights

Just as daybeacons are sometimes substituted for unlighted buoys, lighted buoys are often replaced by minor lights (fig. 4-8). Minor lights are fixed structures of the same overall physical features as daybeacons, but are equipped with lights generally similar in characteristics to those found on buoys. Minor lights can be used in a series with other aids to mark channels, rivers, or harbors and can be used to mark some isolated areas.

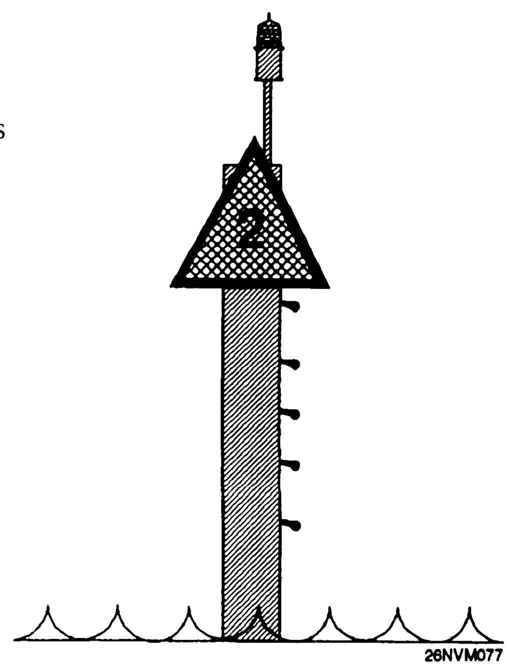


Figure 4-8. Minor light.

The term *minor light* does not include the more important lights marking harbors, peninsulas, major shoals, and so on, which have lights of greater intensity and/or special characteristics and were discussed earlier in this manual. Daymarks are placed on the structures for identification, and reflective material is added for nighttime safety in case the light is extinguished. A minor light normally has the same color, flash, and phase characteristic as that of a lighted buoy. Intensity of the light is generally of the same order as that of a lighted buoy, but visibility may be increased by its greater height above water.

Factors Associated with Navigational Lights

Light Colors

There are only three light colors in common use on fixed lighted navigation aids--white, green, and red. All lighted navigation aids, regardless of the color of their light, are symbolized on a chart either by a magenta colored ray in the form of an exclamation point or by a one-eighth-inch magenta circle, superimposed over a black dot indicating the location of the light.

On charts, the color of the light, if other than white, is indicated by the abbreviations R for red and G for green, written near the light symbol. A white light has no abbreviation on a chart. Thus, if a magenta light symbol appears on a chart with no color abbreviation nearby, the navigator should assume its color to be white.

In the *Light List* and *List of Lights,* however, the color of a white light is indicated by the abbreviation W.

Alternating Lights

If a light is made to change color in a regular pattern, either by alternately energizing different color lights or by passing colored lenses around the same light, the light is an alternating light, abbreviated Al.

Alternating lights used in conjunction with different phase characteristics show a very distinctive appearance that cannot be easily mistaken. Their use is generally reserved for special applications requiring the exercise of great caution, such as airport beacons, harbor entrance lights, and lighthouses.

Sector Lights

Information

Sectors of colored glass are placed in the lanterns of certain lighthouses to indicate danger bearings within which a ship will be in danger of running on rocks, shoals, or some other hazard. The arcs over which a red light shows are the danger sectors whose bearings usually appear on the chart. Although the light is red within the danger arc, its characteristics remain the same. It should be noted, however, that the red light within the red sector may not be as visible as the white light outside that sector.

Sectors may be only a few degrees in width, marking an isolated obstruction, or they may be so wide that they extend from the direction of deep water to the beach.

In most instances, red sectors indicate water areas to be avoided. A narrow green sector may signify a turning point or the best water across a shoal. Exact significance of each sector may be obtained from the chart.

Exercise caution so that the danger sectors are not mistaken for the sectors of good water or that incorrect bearings are taken from the chart.

All sector bearings are true bearings in degrees running clockwise around the light as a center and are expressed as BEARINGS OBSERVED FROM THE SHIP TOWARDS THE LIGHT.

Take a look at the example presented in figure 4-9. The *Light List* Remarks column shows Cape Henry Light (LLNR 365) as having a red sector from 154° to 233°. As long as your ship is within this sector, the light will appear red. In this same example you will also note that the nominal range of the red light is 15 miles, while the same light in the white sector has a nominal range of 17 miles. The reason for this difference is that a white light of a certain intensity is visible for a longer distance than a red light of the same intensity.

Sector Lights, Continued

(1) NO.	(2) NAME AND LOCATION	(3) POSITION	(4) CHARACTERISTIC	(5) HEIGHT	(6) RANGE	(7) STRUCTURE	(8) REMARKS
	SEACOAST (VIRGINIA) - FIFTH DISTRICT						
		N/W					
	OCEAN CITY INLET TO CAPE HATERAS (CHART 12200)						
360	NAVY SESEF LIGHTED BUOY A	36 55.0 75 38.3	FLY 2.5S		5	YELLOW	
365	CAPE HENRY LIGHT	36 55.6 76 00.4	MO (U) W 20S (R SECTOR) TS FL 2S EC. 1S FL 2S EC. 7S FL 7S EC.	164	W 17 R 15	OCTAGONAL PYRAMIDAL TOWER, UPPER AND LOWER HALF OF EACH FACE ALTERNATELY BLACK AND WHITE. 163	RED FROM 154° TO 233° COVERS SHOALS OUTSIDE CAPE CHARLES AND MIDDLE GROUND INSIDE BAY. RBN: 298 KHZ CB (—•—• —•••) ANTENNA 80YDS 326° FROM LIGHT TOWER. EMERGENCY LIGHT OF LOWER INTENSITY WILL BE DISPLAYED WHEN MAIN LIGHT IS EXTINGUISHED.

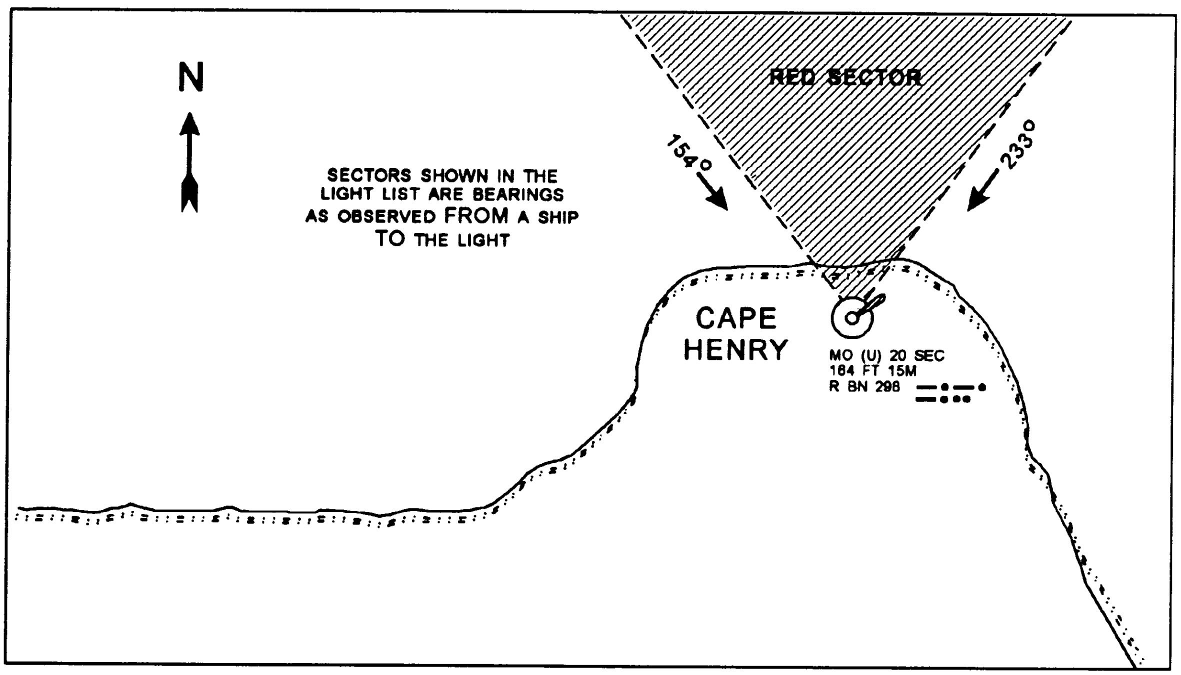


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Figure 4-9. Light sectors are expressed as observed from the ship to the light.

Sector Lights, continued

On either side of the line of demarcation between colored and white sectors, there is always a small sector whose color is doubtful because the edges of a sector cannot be cut off sharply. Under some atmospheric conditions, a white light may have a reddish appearance. Consequently, light sectors must not be relied upon entirely; but position must be verified repeatedly by bearings taken on the light itself or by other fixed objects.

When a light is cut off (obscured) by adjoining land, the arc of visibility may vary with a ship's distance away from the light. If the intervening land is sloping, for example, the light may be visible over a wider arc from a far off ship than from one close inshore.

Emergency Lights

Emergency lights of reduced intensity are displayed from many primary lights when the main light is extinguished. These emergency lights may or may not have the same characteristic as the main light. The characteristic of the emergency lights are listed in column 8 of the *Light List.* Again, refer to the example shown in figure 4-9 for Cape Henry Light (LLNR 365).

RACONs

A RACON is a radar beacon that produces a coded response, or radar paint, when triggered by a radar signal. The coded response appears on your radar screen as a series of dots and dashes. RACONs are placed on important ATONs (buoys or structures) to assist in positive identification of the aid. Column *8* of the *Light List* will describe the RACON signal both as a Morse code letter and the equivalent dots and dashes, for example RACON: X (-..-).

Buoys

Buoys

Buoys are, in effect, floating sign posts for the mariner. Their color, shape, number, light, or sound characteristic tell the mariner how to transit safe water and avoid navigational hazards, and assist the mariner in following the proper course.

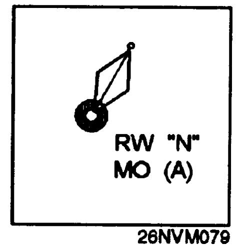

Figure 4-10. Buoy symbol

Buoy symbols shown on charts (see fig. 4-10) indicate the approximate position of the buoy and of the sinker that moors the buoy to the bottom. The approximate position is used because it is difficult to keep a buoy and its moorings in an exact geographical location. These difficulties include, but are not limited to, imprecise methods of position fixing, existing atmospheric and sea conditions, and variations in the seabed's slope and makeup. The position of the buoy can be expected to shift inside and outside the area shown on the chart because they are moored with excess chain. In addition, buoys and sinkers are normally checked only during periodic maintenance visits, which often occur more than a year apart.

Types of Buoys

There are many different types of buoys in our buoyage system, with each type designed to meet certain requirements. All buoys assist mariners during daylight hours, and those with light, sound signals, or both, serve the mariner during darkness or periods of low visibility. The following are the principal types of buoys you will encounter:

<u>Spar buoys</u> are cylindrical in shape and are often constructed from large logs, which are trimmed, shaped, and appropriately painted. Some are metal, plastic, or fiberglass.

<u>Can buoys</u> (fig. 4-11) are built such that the upper portion that you observe resembles a can. These buoys are unlighted and will be painted green or have green and red horizontal bands.

<u>Nun buoys</u> (fig. 4-11) are built such that the upper portion you observe resembles a cone with a rounded tip. Like cans, these are also unlighted and will be painted red or have red and green horizontal bands.

<u>Spherical buoys</u> are unlighted and are round in shape. These buoys are painted with red and white vertical stripes.

Buoys, Continued

Types of Buoys

<u>Bell buoys</u> have a flat top, surmounted by a skeleton steel framework supporting a bell. The bell usually has four clappers, which strike the bell as the buoy moves with the sea.

<u>Gong buoys</u> are similar to bell buoys except they have a series of gongs, each with a different tone.

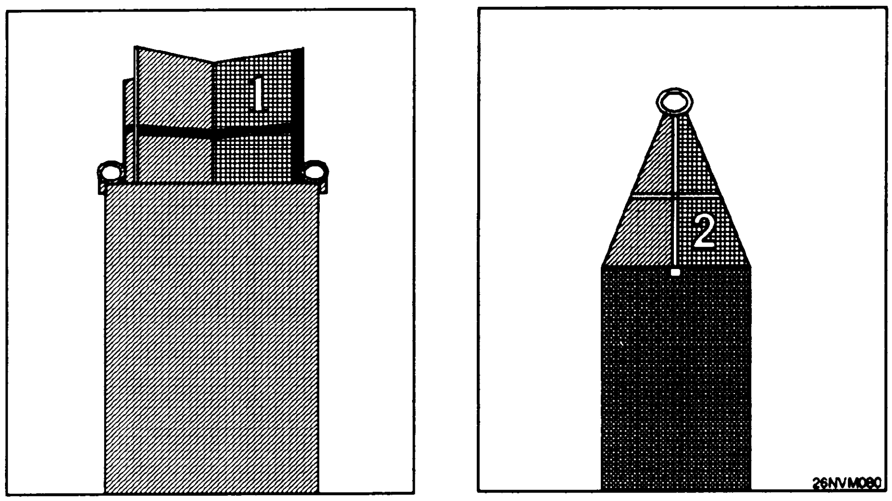

Figure 4-11. Can buoy on the left and nun buoy on the right.

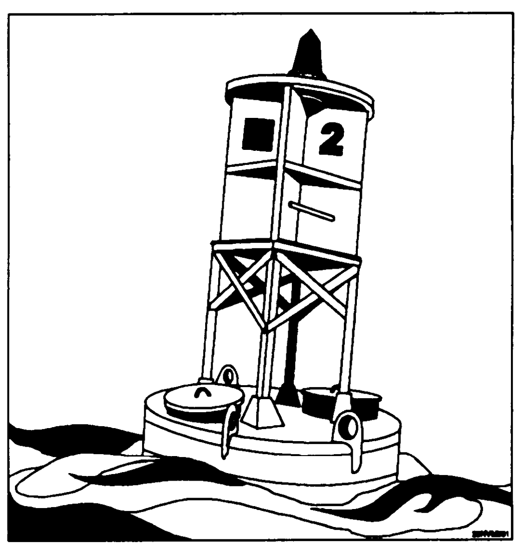

Figure 4-12. Lighted buoy.

Types of Buoys

Whistle buoys are similar to bell buoys except they carry a whistle sounded by the sea's motion or a horn that is sounded at regular intervals by electrical means.

Lighted buoys (fig. 4-12) carry batteries and are surmounted by a framework supporting a light. The framework has no navigational significance, it simply supports the light and sound equipment. Many lighted buoys carry a solar panel atop the light to recharge the battery during daylight hours.

Combination buoys have a combined light and sound signal, such as a lighted bell, gong, or whistle buoy. Some of the most important combination buoys also carry a RACON.

Large Navigational Buoys

Large navigational buoys (LNBs) are disc-shaped buoys that may be as large as 40 feet in diameter.

LNBs provide a platform for a light, fog signal, radiobeacon, and meteorological sensors that transmit data ashore. LNBs were developed primarily to replace manned lightships and light towers.

They are normally stationed many miles from shore and are moved from time to time. Special attention must be paid to these buoys when laying coastal and open ocean tracks.

Buoy Identification

Information

All buoys are fitted with retroreflective materials that show well when illuminated with a spotlight, and most buoys are fitted with radar reflectors.

Retroreflective material is applied to lighted as well as unlighted buoys to increase their visibility. This application greatly assists you in locating aids at night using a searchlight. Retroreflective material may be red, green, white, or yellow; the coloring has the same significance as the colors of lights.

Many buoys are equipped with radar reflectors, which are vertical metal plates set at right angles to each other in such a manner as to greatly increase the echo returned to a radar receiver aboard ship. The plates are shaped and mounted in order to preserve the overall characteristic shape of an unlighted buoy or the general appearance of a lighted buoy. Some buoys have a radar reflector mounted inside the actual body of the buoy.

CAUTION

Although buoys are valuable ATONs, you must never depend exclusively on them—they may fail. Some of the reasons for their failure are as follows:

Passing vessels may hit a buoy and shift it, overturn it, or set it adrift.

Buoys can drag their moorings in heavy weather.

The light on a lighted buoy may fail or be extinguished.

Sound signals may not function because of ice, storm damage, collisions, or other accidents.

Whistles, bells, and gongs actuated by the sea's motion may fail to function in smooth water. For these reasons, a prudent mariner must not rely completely upon the position or operation of buoys, but must also navigate using bearings from fixed structures and ATONs on shore.

Buoyage Systems

Systems

A buoyage system consists of fixed, floating, lighted, and unlighted ATONs. These aids are used to mark waterways. There are two buoyage systems that are in use throughout the world-the **lateral** system and the **cardinal** system.

Lateral System

In the lateral system, aids are placed to mark the sides of a navigable channel. They also mark junctions and bifurcations, indicate the safe side on which to pass hazards, and mark the general safe centerline of wide bodies of water.

In U.S. waters, a vessel returning from seaward and proceeding toward the head of navigation is generally considered as moving southerly along the Atlantic Coast, westerly along the Gulf Coast, and northerly along the Pacific Coast. This is what is known as the "conventional direction" of buoyage. Virtually all U.S. lateral marks are located in what is known as IALA region B and follow the traditional "red right returning" rule.

Cardinal System

In the cardinal system, aids generally mark the geographic relationship to the aid of a hazard in terms of 90-degree quadrants centered on the cardinal directions of north, east, south, and west. The cardinal system is not widely used in the United States and will not be discussed in this text. For more information on the cardinal system, consult *Dutton's Navigation and Piloting* or *Bowditch.*

International Association of Light Authorities (IALA)

Background

In years past, mariners had to be familiar with many different types of buoyage systems worldwide, because there was no standardized system in use. Some of the features of these different buoyage systems had completely opposite meanings, which often led to confusion and accidents. In the mid 1970’s, the International Association of Lighthouse Authorities (IALA) developed and secured acceptance of two systems of buoyage known as IALA A and IALA B. Both systems use a combination of cardinal and lateral marks plus unique marks for isolated dangers, safe-water, and special-purpose areas.

IALA Systems

The IALA system uses buoy shape, color, and, if lighted, rhythm of flashes to convey the desired information to the navigator. The system also uses special topmarks, which are small distinctive shapes above the basic aid to facilitate identification.

<u>IALA System A</u> is used in Europe, Africa, and most of Asia, including Australia and New Zealand. In this system, cardinal marks are widely used. Red buoys are kept to port when entering from seaward; green buoys are kept to starboard.

<u>IALA system B</u> is used in North, Central, and South America, Japan, South Korea, and the Philippines. Cardinal marks are permitted in this system but are seldom used. Red buoys are kept to starboard (red right returning) when entering from seaward, green buoys are kept to port. Figure 4-13 shows how the two IALA regions are divided worldwide.

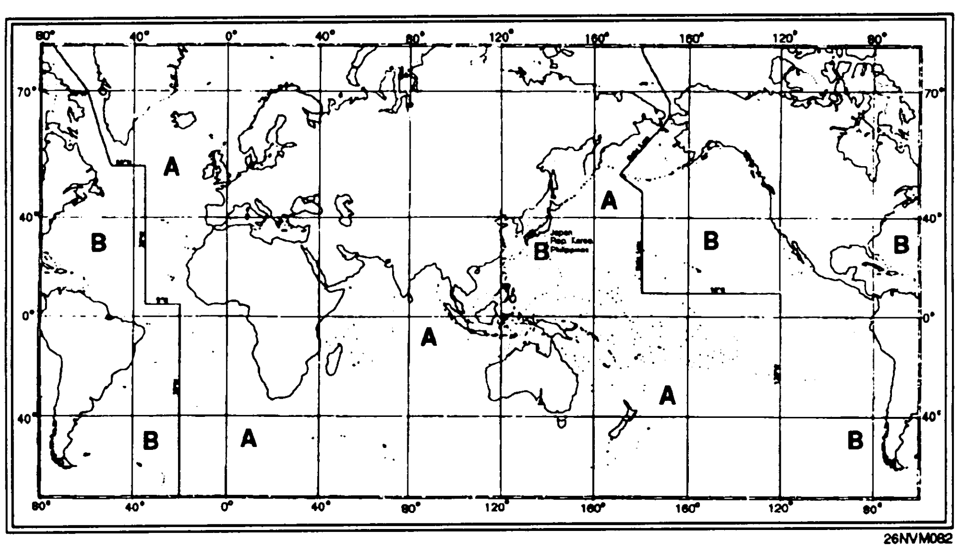

Figure 4-13. The IALA buoyage system.

The United States System of Aids to Navigation

Information

The system of ATONs used in the United States consists of buoys, lights, and daybeacons conforming to the IALA region B guidelines as well as certain variations which are used exclusively in this country. Figures 4-14 through 4-16 graphically display the variations that exist in the U.S. system.

Figure 4-14 shows the U.S. ATONs system as seen entering from seaward.

Figure 4-15 represents a visual buoyage guide for IALA region B.

Figure 4-16 shows how the visual guide would appear on a nautical chart.

Figure 4-17 shows ATONs as they appear on the western rivers of the United States.

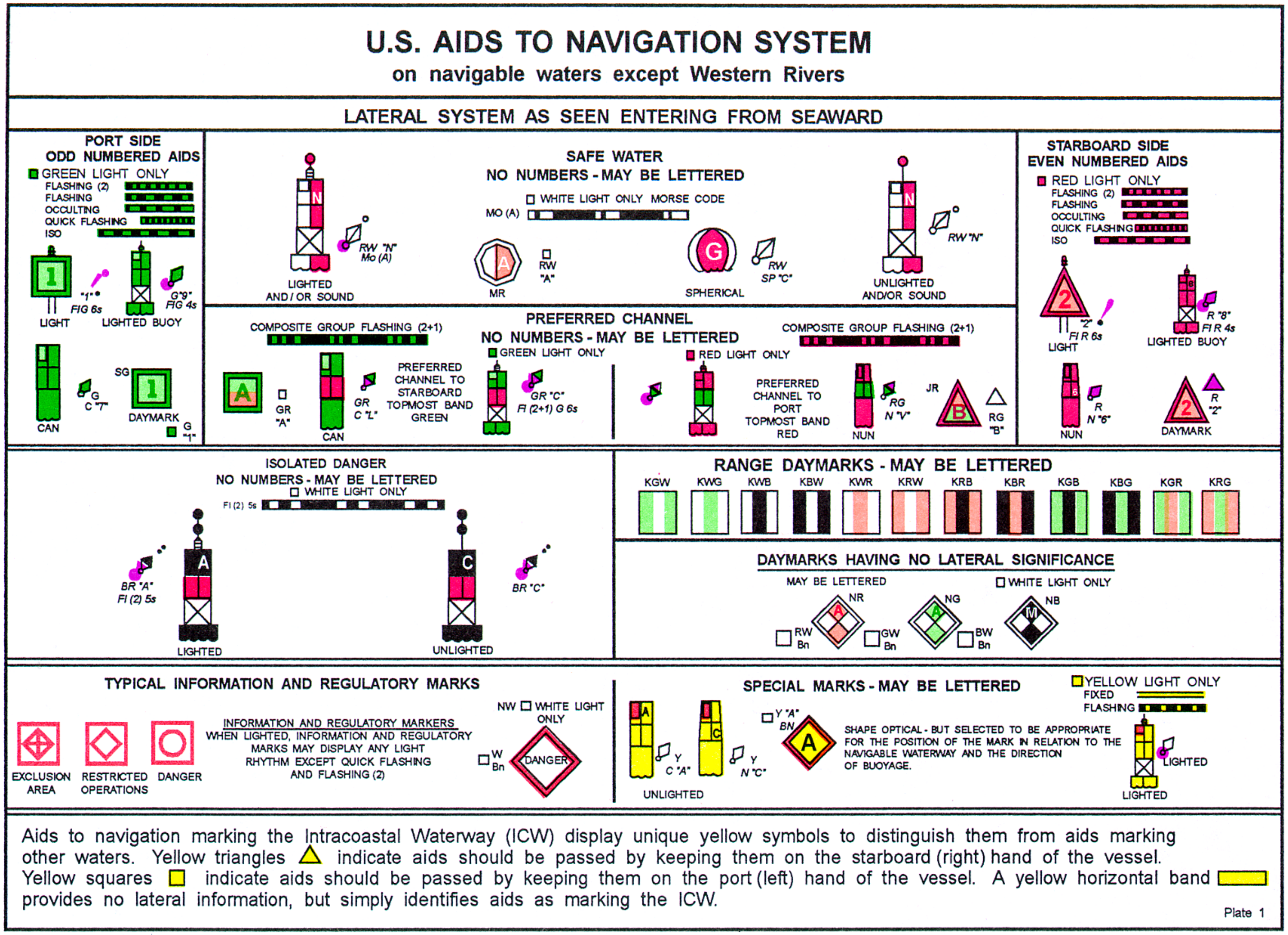

Figure 4-14. Lateral system as seen entering from seaward.

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